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Indian Standard

CIGARETTES AND FILTER RODS — DETERMINATION OF NOMINAL DIAMETER — METHOD USING A LASER BEAM MEASURING APPARATUS

ICS 65.160

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

May 2008 **Price Group 6**

Tobacco and Tobacco Products Sectional Committee, FAD 4

NATIONAL FOREWORD

This Indian Standard which is identical with ISO 2971 : 1998 'Cigarettes and filter rods — Determination of nominal diameter — Method using a laser beam measuring apparatus' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Tobacco and Tobacco Products Sectional Committee and approval of the Food and Agriculture Division Council.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma(,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

The technical committee responsible for the preparation of this standard has reviewed the provisions of the following International Standard referred in this adopted standard and has decided that it is acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 3402 : 1991	Tobacco and tobacco products — Atmosphere for conditioning and testing

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

CIGARETTES AND FILTER RODS — DETERMINATION OF NOMINAL DIAMETER — METHOD USING A LASER BEAM MEASURING APPARATUS

1 Scope

This International Standard specifies a non-contact, scanning laser beam method of gauging for determination of the mean, minimum and maximum diameters and the ovality of rod-shaped objects with a circular or oval cross-section. The method is applicable, in particular, to cigarettes and filter rods.

NOTE 1 Alternative tape gauge and pneumatic balancing orifice measurement techniques are still widely used in the determination of nominal diameters for cigarettes and filter rods. These alternative measurement techniques are discussed in annex C.

NOTE 2 For laboratories using the circumference value instead of the diameter, the circumference value is calculated by multiplying the diameter by pi (π).

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3402:1991, *Tobacco and tobacco products — Atmosphere for conditioning and testing.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1
diameter
arithmetic mean value of a minimum of n readings ($n \geq 100$) performed on a test piece following the method specified in this International Standard

NOTE The diameter is valid as a parameter for rod-like test pieces with a nearly circular cross-section.

3.2
minimum diameter
minimum value obtained from the results of n individual readings performed on a test piece

3.3
maximum diameter
maximum value obtained from the results of *n* individual readings performed on a test piece

3.4
absolute ovality
expression of the out-of-roundness of a rod-like test piece with an oval cross-section

NOTE It can be obtained from the arithmetic difference between the maximum and minimum diameters obtained from *n* individual readings.

3.5
relative ovality
ratio of the arithmetic difference between the absolute ovality and the diameter calculated from *n* individual readings

NOTE 1 Relative ovality is expressed as a percentage.

NOTE 2 Caution should be exercised in interpreting maximum diameters, absolute ovality and relative ovality as these can be affected by the quality of the gum line (raised laps), generating artificially high individual diameter readings.

4 Principle

Using the appropriate device of the apparatus, the test piece is rotated around its longitudinal axis, for a half (180°) or full (360°) rotation, with a constant angular (rotational) speed. Simultaneously, the laser beam moves, parallel to itself, with constant speed, in a plane (called the scan path) which is perpendicular to the longitudinal axis of the test piece.

The intersection of the scan path with the test piece is a cross-section of the test piece.

An individual reading is the measured length of the orthogonal projection of this cross-section on a plane parallel to the axis of the test piece.

This principle is illustrated in figure 1.

5 Apparatus

5.1 Sample conditioning enclosure, capable of maintaining the conditions given in ISO 3402.

5.2 Scanning laser beam measuring apparatus, consisting of the following.

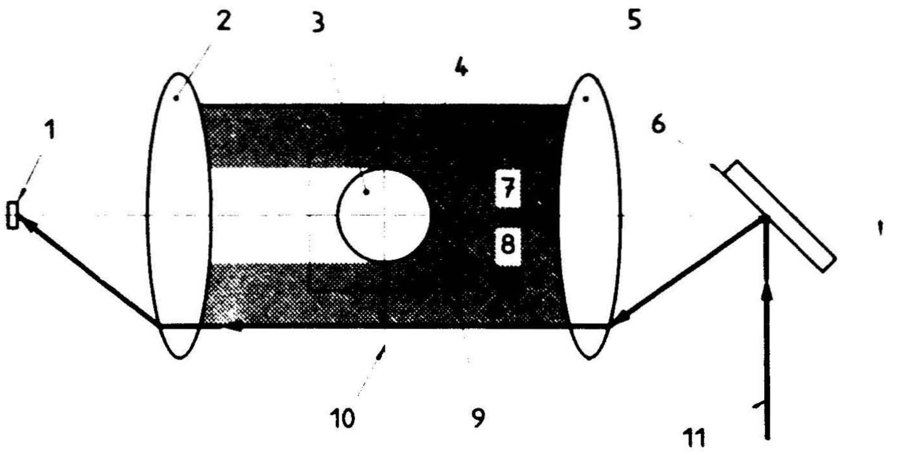
5.2.1 Scanning laser beam measuring instrument, having a resolution of at least 0,005 mm, for the determination of the diameter of rod-like test pieces with a nearly circular cross-section.

The scanning velocity of the laser shall be such that no eccentric motion of the test piece parallel to the longitudinal axis, within the measurement area, shall affect the accuracy of the measurement of mean diameter.

The ratio between the scanning rate of the laser beam apparatus and the rotational speed of the test piece shall be constant and high enough to ensure that the measured diameter, as well as the minimum and maximum values, shall be determined with sufficient accuracy, in spite of possible ovality of the test piece.

The length of the scan path shall be at least 50 % greater than the maximum diameter to be measured and the test piece shall be scanned a minimum of 100 times by the laser beam during a half (180°) or full (360°) rotation.

5.2.2 Apparatus or fixture for rotating the test piece in the scan path of the laser beam or to rotate the scan path of the laser around the test piece while maintaining the longitudinal axis of the test piece perpendicular to the scan path.



Key

1	Receiving element
2	Converging lens
3	Test piece
4	Measurement area
5	Collimator lens
6	Scanning mirror
7 to 8	Scan path
9	Scan centreline
10	Measurement line
11	Laser beam

NOTE For a single-axis scanner, the measurement area surrounds an ideal location found at the intersection of the measurement line and the scan centreline. Best accuracy is achieved when the test piece is within the measurement area.

Figure 1 — Diagram of a single-axis (laser scanner) gauging system

6 Sampling

Take a statistically representative sample of the population of test pieces to be characterized.

Samples shall be free of obvious visible defects which may impair measurement performance.

7 Procedure

7.1 Preparation of test pieces

Select at random, from the sample taken in accordance with clause 6, the number of test pieces required for the test.

Condition the test pieces, prior to measurement, in a conditioning enclosure in accordance with ISO 3402.

The times required for the curing of filter rods and the duration of conditioning for both filter rods and cigarettes are not specified in this International Standard and are to be determined by practical experience. They shall be reported in the test report together with the results.

7.2 Calibration

Working standards are routinely used to calibrate or check the calibration of the laser scanning system. Calibration shall be performed with a minimum of two standards, differing in size by at least 25 % of the measurement range of the instrument, and of dimensions known to accuracies beyond those required for measurement.

The sizes of the test pieces to be measured shall be within the range of those of the calibration standards.

NOTE 1 One intermediate standard can be used on a routine check; its diameter should be near to that of the test piece.

NOTE 2 The essential properties of calibration standards are given in annex A.

7.3 Measurement

In accordance with the manufacturer's instructions, position the test piece within the measurement area, as close as possible to the intersection of the scan centreline and the measurement line.

The test piece, or the scanner, shall be capable of being rotated around the rotation axis such that any eccentric motion of the test piece, relative to the scan path, remains in parallel with the scan path and perpendicular to the longitudinal axis of the test piece.

Adjust the instrument and/or feeding and rotational apparatus for the scan path to scan the required section of the test piece.

Operate the apparatus in accordance with the manufacturer's instructions and accurately record the mean, minimum and maximum diameters.

At least 10 test pieces from one sample should normally be used to determine the mean value of the diameter for the sample.

NOTE 1 In practice, laboratories often take a different number of measurements depending on the application of the measurement.

NOTE 2 It is possible to have either a rotation of the laser beam around the object or a rotation of the object in the laser beam.

NOTE 3 Possible sources of error in measurement of diameter are given in annex B.

NOTE 4 When using old laser beam measuring apparatus, an effect of the roughness of the surface on the measured diameter has been observed (porous plug wrap), which may distort the results by a slight excess.

8 Expression of results

The value of the sample mean diameter shall be the mean value of the individual measurements. See 7.3.

The diameter of individual samples (of rod-like test pieces with a nearly circular cross-section) shall be expressed in millimetres to the nearest 0,01 mm.

The results shall be expressed as follows:

a) diameter, the arithmetic average of at least 100 individual readings scans, is expressed in millimetres to the nearest 0,01 mm;

b) sample mean diameter, the average of x diameter measurements (x is normally 10 but may vary; see note 1 in 7.3), is expressed in millimetres to the nearest 0,001 mm;

c) sample maximum diameter, the maximum diameter obtained from a sample of x test pieces, is expressed in millimetres to the nearest 0,01 mm;

d) sample minimum diameter, the minimum diameter obtained from a sample of x test pieces, is expressed in millimetres to the nearest 0,01 mm;

e) absolute ovality is expressed in millimetres to the nearest 0,01 mm;

f) relative ovality is expressed as a percentage to the nearest 0,1 %.

9 Precision

9.1 Interlaboratory test

An international collaborative study involving eight laboratories was conducted in 1990 on matched samples (filter rods, metal rods, cigarettes) of diameter approximately 7,9 mm, and gave the following values for repeatability limit (r) and reproducibility limit (R).

9.2 Repeatability

The difference between two single results found on matched cigarettes or filter-rod samples, by one operator using the same apparatus within the shortest feasible time interval, will exceed the repeatability limit (r) on average not more than once in 20 cases in the normal and correct operation of the method.

Single measurements:	r = 0,028 mm s_r = 0,01 mm
Mean values from 10 repeated measurements per sample (on one day of test):	r = 0,012 mm s_r = 0,0042 mm

9.3 Reproducibility

Single results on matched cigarettes or filter-rod samples reported by two laboratories will differ by more than the reproducibility limit (R) on average not more than once in 20 cases in the normal and correct operation of the method.

Single measurements:	R = 0,042 mm s_R = 0,015 mm
Mean values from 10 repeated measurements per sample (on one day of test):	R = 0,038 mm s_R = 0,014 mm

10 Test report

The test report shall indicate the method used and the results obtained. It shall also mention any operating conditions not specified in this International Standard, or regarded as optional, as well as any circumstances that may have influenced the results.

The test report shall include all details required for complete identification of the sample.

Specifically the test report shall contain:

a) date of sampling and sampling method;

b) identification and full description of the samples tested, stating the properties (nature, size) of samples

c) date of measurement;

d) precise and full measuring conditions, particularly those deviating from the specifications of this International Standard, and any events likely to have affected the results;

e) test atmosphere and duration of conditioning (see 7.1);

f) results expressed in millimetres (diameter or circumference);

g) elementary statistics relative to results:
   - number of measurements,
   - mean and standard deviation values.

Annex A

(normative)

Calibration standards

A.1 Essential properties of calibration standards

Calibration standards are used to calibrate measuring instruments for the determination of the diameter (or circumference) of cigarettes and filter rods.

The reference calibration standard shall be a cylindrical metal rod with a ground surface finish of about 0,5 µm average roughness and with a known and repeatable value of the diameter.

The working calibration standard shall be calibrated against a traceable reference standard under standard laboratory conditions of 22 °C ± 5 °C. The thermal expansion coefficient of the material shall be known.

The working calibration standard shall be checked for ovality by measuring the diameters of a minimum of three cross-sections, situated near the middle and two ends respectively.

The calibration standards shall be inscribed with their measured value quoted to a minimum accuracy of the diameter of 0,005 mm absolute and have a unique identification.

A.2 Procedure for calibration of instruments

The calibration and performance testing of instruments for the determination of the diameter of cigarettes and filter rods should be conducted in accordance with instrument manufacturer's instructions.

Annex B
(informative)

Information on possible sources of measurement errror

B.1 Sources of measurement error

Optimal measurement conditions should be maintained by avoiding the following sources of measurement error:

a) selection of test pieces that have raised seams (bad laps);

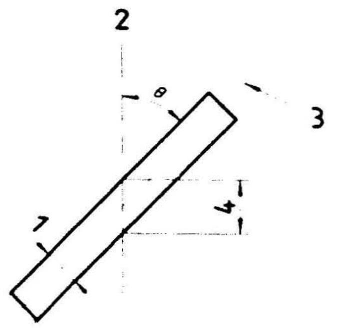
b) dust or debris on the transmitter or receiver scan windows can produce incorrect measurements; the instrument manufacturer's recommended cleaning procedure should be followed;

c) incorrect placing of the test piece in the measurement area will produce measurement errors; the test piece should be placed in the plane of, and at right angles to, the scanning beam; avoid tilting the longitudinal axis of the test piece in the vertical plane with respect to the scan path; the greater the object's angle with the scan path, the greater the measurement error will be, as illustrated in figure B.1;

d) an eccentric movement of the cigarette may induce some measurement errors; these should be limited, in particular for products with high ovality;

e) the use of different measuring areas may induce measurement errors;

f) some errors may occur if the entire number of half-rotations is not adhered to.



Key

1 Actual diameter
2 Scan path
3 Longitudinal axis
4 Measured diameter

Figure B.1 — Illustration of measurement error

B.2 Error magnitude

$$\text{Error} = D\left(\frac{1}{\cos\theta} - 1\right)$$

where

D is the actual diameter;

θ is the angle of tilt by comparison with the scan path.

Annex C

(informative)

Alternative measurement techniques for the determination of nominal diameter of cigarettes and filter rods

C.1 Tape gauge measurement

C.1.1 Principle

This measurement technique employs a flexible tape which is wrapped around the circumference of a cigarette or filter rod and held with a controlled tension, applied by means of a drop-weight of a chosen value of between 60 g to 100 g.

One end of the tape is attached to a transducer, used to relate linear travel to a directly proportional voltage; the other end is anchored to a datum.

The tape, when wrapped around the sample, precisely conforms to the shape of the circumference of the sample. Therefore the remaining length of tape, which directly relates to the circumference of the sample, is measured.

C.1.2 Advantages

The advantage of the tape gauge is that it precisely measures the circumference of the sample, regardless of its shape, and overcomes any problems that could be incurred by other techniques due to the presence of raised laps. Measurement of the circumference provides greater resolution of measurement in determining the nominal diameter.

C.1.3 Disadvantages

The disadvantage of the tape gauge is that a range of drop-weights are required to negate any constricting effect on low density products and that the tape gauging technique cannot determine the maximum and minimum diameters of a product.

Nominal diameter is calculated from the measured value of the circumference.

NOTE The chosen drop-weight will affect the diameter measured, especially when measuring cigarette diameter directly after manufacture.

C.2 Pneumatic balancing orifice measurement

C.2.1 Principle

A pneumatic bridge circuit, is supplied with air at very low regulated pressure and is divided along two paths, one for measurement and the other for balancing.

A manometer or differential pressure sensor is used to indicate the difference in pressure between the measuring and balancing lines, as determined by the size of the sample, placed in the measuring head.

This measurement directly relates to the cross-sectional area of the sample, which is subsequently reported as nominal diameter or circumference.

C.2.2 Advantages

This measurement technique has the advantages that it is simple and requires little technological support and only requires a compressed air supply to function.

A manometer and scale provide an easy-to-read indication of any specified mean circumference or diameter, and of deviations from it in fractions of a millimetre.

C.2.3 Disadvantages

Distinct measurement heads are required for each measurement range, typically ± 0,25 mm diameter (± 0,7 mm circumference), relative to any specific nominal diameter or circumference.

Measurements are mainly affected by the level of permeability of the sample wrapper and some also by the bulk density of the sample.

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Amendments Issued Since Publication

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